

1 WE CLAIM:

2       1. A method of obtaining data for a geographic database comprising:  
3           providing data indicating a plurality of locations along roads, including data  
4           indicating altitudes at the plurality of locations;  
5           computing road grade values for a plurality of subsections of the road, each of the  
6           subsections being a portion of the road between two of the locations;  
7           identifying a plurality of temporary change points, each of the temporary change  
8           points joins two adjacent subsections having road grade values that differ by a value  
9           greater than a predetermined amount;  
10          computing a road grade value for each part of the road between adjacent  
11           temporary change points;  
12          grouping consecutive parts of the road having road grade values that fall within a  
13           predetermined range into at least one constant road grade section; and  
14          storing data that define the constant road grade section in the geographic database.

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16       2. The method of Claim 1 further comprising filtering the data to remove  
17           closely spaced locations.

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19       3. The method of Claim 1 further comprising deriving a smooth altitude  
20           profile along the road.

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22       4. The method of Claim 3 wherein the smooth altitude profile is derived  
23           using a least squares polynomial.

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25       5. The method of Claim 1 wherein the temporary change points include a  
26           plurality of zero-crossing points, wherein each of the zero-crossing points joins two  
27           adjacent subsections having road grade values that change from positive to negative.

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1           6.     The method of Claim 5 wherein the temporary change points include a  
2     plurality of pseudo zero-crossing points, wherein each of the pseudo zero-crossing points  
3     joins two adjacent subsections between zero-crossing points having road grade values  
4     that differ by a value greater than a predetermined amount.

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6           7.     The method of Claim 6 wherein said pseudo zero-crossing points are  
7     identified by performing a rotational transformation of an altitude profile between two  
8     adjacent zero-crossing points.

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10          8.     The method of Claim 1 further comprising:

11           determining whether the constant road grade section has a corresponding road  
12     distance less than a minimum distance; and

13           if the constant road grade section has the corresponding road distance less than  
14     said minimum distance, merging the constant road grade section with an adjacent  
15     constant road grade section.

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17          9.     A method of obtaining data for a geographic database comprising:

18           providing data indicating a plurality of locations along roads, including data  
19     indicating altitudes at the plurality of locations;

20           computing a road grade value for each of a plurality of subsections of said road,  
21     each of the subsections defined by two of the locations;

22           if the road grade values of adjacent subsections fall within a predetermined range,  
23     grouping the subsections into at least one constant road grade section; and

24           storing data that define the constant road grade section in the geographic database.

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26          10.    The method of Claim 9 further comprising deriving a smooth altitude  
27     profile along the road.

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29          11.    The method of Claim 9 further comprising identifying a grade change  
30     point corresponding to a position connecting adjacent constant road grade sections.

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1           12.    The method of Claim 9 further comprising:  
2           determining whether the constant road grade section has a corresponding road  
3           distance less than a minimum distance; and  
4           if the constant road grade section has the corresponding road distance less than  
5           said minimum distance, merging the constant road grade section with an adjacent  
6           constant road grade section.

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8           13.    The method of Claim 9 further comprising computing a road grade value  
9           for the constant road grade section.

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11          14.    The method of Claim 13 further comprising:  
12           if the road grade value of the constant road grade section is greater than a  
13           maximum road grade value, identifying the constant road grade section for human  
14           inspection.

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16          15.    The method of Claim 13 further comprising:  
17           if the road grade value of the constant road grade section is greater than a  
18           maximum road grade value, merging the constant road grade section with an adjacent  
19           constant road grade section.

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21          16.    The method of Claim 9 further comprising using the data indicating  
22           altitudes as an input to a Hough Line Transform to determine straight line segments  
23           corresponding with the constant road grade sections.

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1           17. A method of representing road geometry for a geographic database  
2 comprising:

3           providing data indicating a plurality of locations along roads, including data  
4 indicating altitudes at the plurality of locations;

5           computing a road grade value for each of a plurality of subsections of the road,  
6 each of said subsections defined by a pair of locations;

7           if said road grade values of adjacent subsections differ by a value greater than a  
8 predetermined amount, identifying said location between said adjacent subsections as a  
9 grade change point; and

10          storing data that define said grade change point in the geographic database.

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12          18. The method of Claim 17 identifying a road grade value for each constant  
13 road grade section between adjacent grade change points.

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15          19. The method of Claim 17 further comprising:

16           determining whether a road distance between adjacent grade change points is less  
17 than a minimum distance; and

18           if the road distance between adjacent grade change points is less than said  
19 minimum distance, eliminating one of said adjacent grade change points.

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21          20. A method of representing road geometry for a geographic database  
22 comprising:

23           providing data indicating a plurality of locations along roads, including data  
24 indicating altitudes at said plurality of locations;

25           using the data indicating altitudes and horizontal distance along the road as inputs  
26 to a Hough Line Transform to determine a plurality of straight line segments  
27 corresponding to a plurality of constant road grade sections along the road; and

28           storing data that define said constant road grade sections in the geographic  
29 database.

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1           21. The method of Claim 20 further comprising identifying a grade change  
2 point corresponding to a location of an intersection of adjacent straight-line segments  
3 determined by the Hough Line Transform.

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5           22. The method of Claim 20 further comprising identifying a road grade value  
6 of one of said constant road grade sections as a slope of said corresponding straight-line  
7 segment.

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